

SPECIFICATION L-108. INSTALLATION OF UNDERGROUND CABLE AND CONDUCTORS FOR AIRPORTS

DESCRIPTION

108-1.1 GENERAL.

a. This Work consists of furnishing and installing underground cable, conductors, and flexible polyethylene duct in accordance with these Specifications at the locations shown in the Contract Documents. This Work includes excavation and backfill of the trench, installation of cable and counterpoise wire in trench, duct, conduit or by plowing, the location and protection of existing circuits, splicing, cable marking, and testing of the installation, site installation, and all incidentals necessary to place the cable in operating condition as a completed unit.

108-1.2 THIS SPECIFICATION INCLUDES:

- a. Regulatory Requirements.
- b. Underground Cable.
- c. Bare Counterpoise Wire.
- d. Underground Wire/Cable Connections.

108-1.3 OTHER RELATED SPECIFICATIONS.

- a. L-100-1.1 through L-100-2.17 General Requirements.

108-1.5 CLASSIFICATIONS.

- a. Type C Cable and Conductors - 600V to 5000V with cross linked polyethylene insulation.

EQUIPMENT AND MATERIALS

108-2.1 REGULATORY REQUIREMENTS.

a. Airport lighting equipment and materials requiring Federal Aviation Administration (FAA) specifications shall have the prior approval of the FAA, and be listed in the latest edition of Advisory Circular (AC) 150/5345-53, Appendix 3.

b. All other electrical equipment and materials shall be subject to acceptance through manufacturer's certification of compliance as required in Specification L-100.

108-2.2 UNDERGROUND CABLE. Underground cable shall conform to the requirements of the latest edition of AC 150/5345-7, Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits.

If telephone control cable is used as control cable, it shall be copper shielded, polyethylene insulated and jacketed, No. 19 AWG telephone cable conforming to the United States Department of Agriculture, Rural Electrification Administration (REA) Bulletin 345-14, REA Specification for Fully Color-Coded, Polyethylene Insulated, Double Polyethylene-Jacketed Telephone Cables for Direct Burial.

Where bare copper counterpoise conductors are to be installed where soil conditions would adversely affect bare copper wire, thermoplastic wire conforming to Fed. Spec. J-C-30, Type TW, 600 volt, may be used.

Cable type shall be Classification Type C. Size, number of conductors, strand and service voltage are specified in the Contract Documents.

108-2.3 BARE COUNTERPOISE WIRE. Bare copper wire for counterpoise installations shall be stranded wire conforming to ASTM Specifications B 3 and B 8.

108-2.4 UNDERGROUND WIRE/CABLE CONNECTIONS. In-line connections of underground cables shall be of the type called for in the Contract Documents, and shall be one of the following types. Series circuit connectors shall conform to the latest edition of AC 150/5345-26.

a. Cast Splice. A cast splice, employing a plastic mold and using epoxy resin equal to that manufactured by Minnesota Mining and Manufacturing (3M) Company, "Scotchcast" Kit No. 82—A, or as manufactured by Hysol Corporation, "Hyseal Epoxy Splice" Kit No. E1135, for potting the splice is approved. The means of splicing telephone control cable is by using 3M "Scotchcast" kits 89—D through 89—D3 or 8981 through 8985 or equal.

b. Vulcanized Splice. A vulcanized splice employing Joy Manufacturing Company's Vulcanizing Kit No. X-1604-8 or equal is approved for field vulcanized splices. Use the proper molds for various cable sizes.

c. Field-attached Plug-in Connector. Use L-823 Plug and Receptacle, Cable Connectors, Class I Type B, employing connector kits, for field attachment to single conductor cable per the Contract Documents.

d. Factory-Molded Plug-in Connector. Specification for L-823 Connectors, Class I, Type A, Factory-Molded to Individual Conductors, are approved.

e. Taped Connections. Taped connections employing field-applied rubber, or synthetic rubber tape covered with plastic tape are approved. Double tape the secondary connector joint. The first layer of tape shall be 3M, #13 rubber tape or equal. The second layer of tape shall be 3M, #38 plastic tape or equal. Lap the second layer of tape over the first layer of tape. In all the above cases, use crimp connectors to make connections of cable conductors utilizing a crimping tool designed, to make a complete crimp before the tool can be removed. No. 19 AWG telephone control wires may be connected by means of wrapped and soldered splice, 3M Company Moisture Proof UR Type Connector, or equal.

CONSTRUCTION METHODS

108-3.1 GENERAL. Install the specified cable at the approximate locations indicated in the Contract Documents.

Locate and mark all existing circuits near the construction of new circuits with flagging through the turf area prior to the excavating operation by the Contractor.

The Contractor is entirely responsible for locating and identifying existing underground cables. Do not, under any circumstances, deliberately plow or trench across existing conductors for the sole purpose of locating cables. Cable that is cut and is not designated for replacement shall be replaced at Contractor's expense in its entirety from edge light unit to unit. Replace home run circuits in their entirety or install a UL or ETL listed pull box for a cast splice, at the Contractor's expense.

Cable connections between lights will be permitted only at the light locations for connecting the underground cable to the primary leads of the individual isolation transformers. The Contractor shall be responsible for providing cable in continuous lengths for home runs or other long cable runs without connections, unless otherwise shown in the Contract Documents.

Acclimate cable to the installed ambient temperature before installation commences (1 hour minimum).

All direct burial splices shall be in a manhole or a hand hole. With the exception of stake mounted lights per Specification L-125, splicing of buried cables directly in the soil is not permitted.

108-3.2 INSTALLATION IN DUCT OR CONDUIT. This Work includes the installation of the cable in duct or conduit as described herein. The maximum number and voltage ratings of cables installed in each single duct or conduit, and the current-carrying capacity of each cable shall be in accordance with the latest edition of NFPA 70.

Install the duct or conduit as a separate Pay Item in accordance with Specification L-110, "Installation of Airport Underground Electrical Duct." Make sure that the duct is open, continuous, and clear of debris before installing cable. Install the cable in a manner to prevent harmful stretching of the conductor, injury to the insulation, or damage to the outer protective covering. Seal the ends of all cables with moisture-seal tape before pulling into the conduit and left seal it until connections are made. Where more than one cable is to be installed in a duct under the same Contract, pull all cable in the duct at the same time. Pull cable through ducts or conduits by hand winch or power winch with the use of cable grips or pulling eyes. Pulling tensions should be governed by recommended standard practices for straight pulls or bends. Where pulling lubricant is required use a lubricant recommended for the type of cable being installed. Replace duct or conduit markers temporarily removed for excavations and include the cost in the price for cable installation.

108-3.3 TRENCHING. Where turf is well established and the sod can be removed, carefully strip and properly store it. Trenches for cables may be excavated manually or with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of shoulder surface is disturbed. Do not use road graders to excavate the trench with their blades. The bottom surface of trenches shall be essentially smooth and free from coarse aggregate. Unless otherwise specified, excavate cable trenches to a depth as indicated in the Contract Documents.

Excavate all cable trenches to a width as indicated in the Contract Documents. Widen the trench where more than two cables are to be installed parallel in the same trench as shown in the Contract Documents. Unless otherwise specified in the Contract Documents, install all cables in the same location and running in the same general direction in the same trench.

When rock excavation is encountered, remove the rock to a depth of at least 3 inches (75 mm) below the required cable depth and replace it with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch (6 mm) sieve. Ascertain the type of soil or rock to be excavated before bidding. Excavation shall be incidental to this Pay Item.

108-3.4 INSTALLATION IN TRENCHES. Mechanical cable-laying equipment may be used in conjunction with a trenching machine if indicated in the Contract Documents; and it should provide for physical inspection of cable prior to backfilling. Sharp bends or kinks in the cable are not permitted.

Unreel cables in place alongside or in the trench and carefully place the cable along the bottom of the trench. Do not unreel the cable and pull into the trench from one end.

Whenever cables (including counterpoise) cross, adjust the trench depth to provide 3" vertical clearance between 5KV conductors; 6" vertical clearance between 600V conductors and 5KV conductors; and 4" vertical clearance between any conductor and the counterpoise conductor. Counterpoise shall always maintain an 8" vertical depth at the edge of pavement and 18" vertical depth when the counterpoise is located above home run circuits. All other cables shall meet NFPA section 70 requirements.

Leave cable slack on each side of all connections, insulating transformers, light units, and at all other points where cable is connected to field equipment. Place the slack cable in the trench in a series of S curves. Leave additional slack cable in runway light bases, handholes, manholes, and other locations where it is required to bring the cable above ground level to make connections. The amount of slack cable shall be as shown in the Contract Documents. Slack cable for above ground connections will be paid as defined in Method of Measurement.

108-3.5 BACKFILLING. After the cable or conductors have been installed on a 3" sand bedding, the first layer of backfill shall be loose measurement, and shall be sand containing no mineral aggregate particles that would be retained on a 1/4-inch (6 mm) sieve. Do not compact this sand backfill layer. The second and subsequent layers shall be as shown on the Drawings and shall contain no particles larger than 1 inch (25 mm) maximum diameter. The top layer of the backfill shall be topsoil. Do not place material in a manner that would stress or damage the cable.

Thoroughly tamp and compact the second, and subsequent layers to at least the density of the adjacent undisturbed soil, and to the satisfaction of the Engineer. If necessary to obtain the desired compaction, moisten or aerate the backfill material as required.

Trenches shall not be excessively wet and shall not contain pools of water during backfilling operations. Completely backfill the trench and tamp it level with the adjacent surface, except that when sod is to be placed over the trench, stomp the second backfilling at a depth equal to the thickness of the sod to be used, with proper allowance for settlement. Remove excess excavated material and dispose of it in accordance with the Contract Documents. All backfilling shall be incidental and the cost included in the Pay Items contained in the Schedule of Prices

Trenches for polyethylene duct will not require sand bedding or a first layer of sand backfill. However, the second and subsequent layers and top layer of topsoil shall comply with paragraph 108-3.5.

108-3.6 RESTORATION. Restore pavement and other surface features disturbed by trenching, plowing, cable installation, storage of materials, and other Contractor operations, to a condition equal to or exceeding that which existed prior to construction. Restore turf as follows:

a. When grading limits are shown on the Plans and the Schedule of Prices contains Pay Items for Salvaged Topsoil, Seeding, Fertilizing, and Mulching, restore the area within the grading limits in accordance with requirements shown on the Plans and contained in the turfing Specifications for areas disturbed by grading operations.

b. Complete turf restoration, for turf disturbed by trenching, plowing, and cable installation outside grading limits, or when there are no grading limits shown, by removing and replacing existing sod or by replacing the disturbed turf with topsoil or salvaged topsoil, seeding, and mulching, in accordance with Specification T-901, T-902, T-905, and T-908. The finished surface upon completion of restoration shall be graded smooth and uniform to match existing slope, and shall be free from ruts over 1 inch in depth and stones over 1 inch in diameter. Maintain and water the turf. Replace seeded areas that do not "catch."

108-3.7 CABLE AND SPLICE MARKERS. Define the location of runway light circuits and splices with concrete markers. In general, mark home run circuits from the runway lights approximately every 200 feet (60 m) along the cable run, with an additional marker at each change of direction of cable run. Mark all other cable buried directly in the earth in the same manner. Do not install markers where cable lies in straight lines between pavement edge lights or obstruction light poles which are spaced 300 feet (90 m) apart, or less. Install markers immediately above the cable or splice. Impress the legend and directional arrows on each marking slab as required by the Contract Documents. The letters shall be approximately 4 inches (100 mm) high and 3 inches (75 mm) wide, with width of stroke 1/2 inch (12 mm) and 1/4 inch (6 mm) deep. Legends inscribed by hand in wet concrete are not acceptable. Edge expose concrete with a 1/4 inch radius tool.

108-3.8 PLOWING. Plowing equipment shall be of the vibratory type.

The plow blade shall be of sufficient length to facilitate installation of the cable conductors or non-metallic conduit at the specified depth. Size the shoe throat for the cable size and the number of cable conductors or non-metallic conduit specified. Cable ways and guides shall be smooth, free of obstructions and sharp edges, and shall not cause bending of the cable conductors or non-metallic conduit at shorter than 6 times their radius. It also shall not cause excessive cable strain which may damage cable insulation or stretch the conductor. Maintain adequate cable on the reel to avoid splices.

For ground rods, dig a hole along the cable route at each ground rod location. The diameter of this hole shall be as necessary and the depth shall be 10 inches deeper than the cable. There shall be a measure of slack at each ground rod to perform the connection process and accommodate movement caused by frost heaving.

At the light hole and duct hole, stop the plow (movement and vibration), raise it and hand pull the required amount of slack. Take care during this operation that the cable at the entrance into the light hole is not pulled from the specified depth. Continue plowing by lowering the plow, starting it and holding the cable by hand before it is firmly held by the ground.

The cable may be unreel along the proposed cable route before plowing or the cable reels may be mounted on the tractor. In the latter case, unreeling of the cable shall not cause excessive tension in the cable.

After the tractor and the plow are positioned at the beginning of the run, sufficient cable conductor or non-metallic conduit slack shall be pulled through the throats. Then lower the plow into the hole and hand hold the cable for the start of plowing.

Do not back the plow onto the cable or conductors.

When an underground obstruction is encountered, lift the plow out of the ground. After the obstruction has been removed, dig an opening around the cable down to the depth of the cable and large enough to lower the plow. Then lower the plow into the opening. While this is being done, pull the cable back into the throat by hand to prevent kinks or sharp bends. Do not bend cable sharper than six times the radius of the cable, conductor, or non-metallic conduit.

After installation by plowing, level the disturbed earth at the surface and if necessary, compact it to the density of the adjacent undisturbed earth.

Mark the location of each underground cable splice in a handhole by a marker placed above the handhole. Impress the word "splice" on each slab.

108-3.9 CONNECTIONS. In line connections of the type shown in the Contract Documents shall be made by experienced personnel regularly engaged in this type of work and shall be made as follows:

a. Cast Splices. Use crimp connectors for jointing conductors. Assemble molds and mix and pour the compound in accordance with manufacturer's instructions and to the satisfaction of the Engineer.

b. Vulcanized Splices. Use crimp connectors for joining conductors. Make the splice using compounds furnished by the manufacturer, in accordance with the manufacturers instructions and to the satisfaction of the Engineer.

c. Field-attached Plug-in Connectors. Assemble these in accordance with manufacturer's instructions. Make these splices by plugging directly into mating connectors. In all cases seal the joint where the connectors come together with heat shrink tubing as required by the Contract Documents and these Specifications.

d. Factory-Molded Plug-in Connections. Make these by plugging directly into mating connectors. In all cases, wrap the joint where the connectors come together with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 inches (37 mm) on each side of the joint.

e. Taped Connections. Make a taped splice in the following manner:

Bring the cables to their final position and cut so that the conductors will butt. Remove insulation and jacket allowing for bare conductor of proper length to fit compression sleeve connector with 1/4 inch (6 mm) of bare conductor on each side of the connector. Use a sharp knife to pencil insulation and jacket at approximately the same angle as a pencil point. Care must be taken to avoid nicking or injuring the conductor during removal of insulation or penciling. Do not use emery paper on splicing operations since it contains metallic particles. Thoroughly clean the copper conductors. Join the conductors by inserting them equidistant into the compression connection sleeve. Crimp conductors firmly in place with a crimping tool that requires a complete crimp before the tool can be removed. Test the crimped connection by pulling on the cable. Scrape the insulation to assure that the entire surface over which the tape will be applied (plus 3 inches (75 mm) on each end) is clean. After scraping, wipe the entire area with a clean lint-free cloth. Do not use solvents.

Apply specified high-voltage rubber tape one-half lapped over bare conductor. This tape should be tensioned as recommended by the manufacturer. Voids in the connector area may be eliminated by highly elongating the tape stretching it just short of its breaking point. Throughout the rest of the splice less tension should be used. Always attempt to exactly half-lap to produce a uniform buildup. Continue buildup to 1-1/2 times cable diameter over the body of the splice with ends tapered a distance of approximately 1 inch (25 mm) over the original jacket. Cover rubber tape with two layers of specified vinyl pressure-sensitive tape one-half lapped. Do not use glyptol or lacquer over vinyl tape as they react as solvents to the tape. No further cable covering or splice boxes are required.

If shielded cable is to be spliced, prepare cable as for a regular taped splice, except remove the neoprene jacket a distance not less than 5 inches (125 mm) from the beginning of the penciled portion. Carefully unwrap the shielding tape from that portion where jacket has been removed and cut off so that it extends about 1 inch (25 mm) from end of the jacket. Proceed with the taped splice as described above and tape up to 1/4 inch (6 mm) from the shield on both ends. Build up rubber tape to a thickness equal to the insulation thickness or 5/16 inch (9 mm) over connector.

Next wrap one-half lapped layer of semi-conducting tape (Scotch No. 13 Semi-Conducting Tape, or equal) over splicing tape and 1/4 inch (6 mm) onto the shielding tape. Wrap a fine, flat shielding braid one-half lapped over the splice extending 1/2 inch (12 mm) onto the metallic shielding. Solder ends of braid to metallic shielding tape. A bonding wire, (Minimum No. 14 Stranded Copper) equal to the current carrying capacity of the metallic shield, should have the individual strands wrapped around the metallic shield at both ends of the splice. These strands should be tack soldered to the shield in several places. The cable sheath should be replaced by wrapping with two one-half lapped layers of vinyl tape extending 2 inches (50 mm) onto the cable jacket.

The above described splice is for a straight-through splice with continuity of shielding.

f. Heat Shrink Connections. Make these with a heat shrinkable insulating cover, specifically designed for splices and terminations per UL 486D. The heat shrink material shall be made of thermally stabilized cross linked polyolefin, rated 90°C, designed with a 3:1 shrink ratio. The material shall have a factory internally applied adhesive sealant, which is applicable to metal, plastic and elastomeric insulating materials.

Heat shrink application and installation procedures, shall conform to the manufacturers instructions.

g. Connection Rating. The dielectric strength and insulation rating of all connection materials, application and installation methods, shall be equal to or exceed the rating of the cables or conductors spliced together.

108-3.10 BARE COUNTERPOISE WIRE INSTALLATION AND GROUNDING FOR LIGHTNING PROTECTION. When shown in the Contract Documents, install a stranded or solid bare copper wire, No. 8 AWG minimum size, for lightning protection of the underground cables. Install the bare counterpoise wire as required in the Contract Documents. Install homerun circuits in the same trench for the entire length of the insulated cables it is designed to protect. Securely attach the counterpoise wire to copper or copper-clad ground rods installed not more than 500 feet (150 m) apart for the entire circuit and at the beginning and end of each counterpoise circuit. The ground rods shall be of the length and diameter specified in the Contract Documents, but never less than 8-feet (2.4 m) long nor less than 5/8 inch (15 mm) in diameter.

Terminate the counterpoise system outside structures that enclose the power source for the circuit protected. Make the connections as shown in the Contract Documents.

108-3.11 TEST, LOCATE AND PROTECT EXISTING CIRCUITS. Work includes the testing and location of all power and control circuits that are located within the construction area or haul routes: providing temporary connection/cable runs to enable operation as required by construction staging of airport lighting systems during darkness, weekends, holidays and instrument conditions; prompt repair or replacement of electrical cables or equipment damaged during construction operations; careful handling of any FAA installed cables or equipment encountered during construction; and removal/reinstallation of existing cables.

Immediately prior to construction, obtain meggar test readings of all airport circuits that will be encountered during construction, including those crossed by haul routes or access roads, shall be taken in the presence of the Sponsor and the Engineer. If the Contractor notes problems in the existing circuits prior to starting Work, these circuits may be repaired by the Sponsor or noted to the mutual satisfaction of the Contractor and the Sponsor as not being the responsibility of the Contractor. Test circuits repaired by the Sponsor once again prior to construction.

Upon completion of construction, in the presence of the Sponsor and the Engineer, Meggar test all airport circuits encountered during construction. Repair all portions of circuits that have been damaged during construction.

The excavation, cutting, pulling-out and reinstallation of existing cables as required in the Contract Documents shall be incidental to this Pay Item. Provide temporary above-ground connections in protective conduit, as shown on Contract Documents or as conditions and environment warrant. All temporary connections shall use L-823 cable connectors, taped and waterproofed as shown on the Contract Documents. The Contractor's superintendent or on-site representative must remain in communication with the Engineer until such repairs are completed and the lighting system has been checked for operation and accepted by the Sponsor.

108-3.12 FINAL ACCEPTANCE AND TEST. Furnish all necessary equipment and appliances per Specification 100-2.13 for testing the underground cable circuits after installation. Test and demonstrate the following:

- a. That all lighting power and control circuits are continuous and free from short circuits.
- b. That all circuits are free from unspecified grounds.
- c. That the insulation resistance to ground of all ungrounded constant current circuits meets the requirements of Table 1.
- d. That the insulation resistance to ground of all ungrounded constant voltage circuits meets the requirements of Specification 100-3.3(h).

TABLE 1. INSULATION RESISTANCE TO GROUND

<i>CIRCUIT LENGTH IN FEET</i>	<i>MINIMUM MEGOHMS AT 500VDC</i>	<i>MINIMUM MEGOHMS AT 1000VDC</i>
10,000 OR LESS	50	45
10,000 – 20,000	40	36
20,000 OR MORE	30	27

- e. That all circuits are properly connected in accordance with applicable wiring diagrams.
- f. That all circuits are operable. Tests shall be conducted that include operating each control not less than 10 times and the continuous operation of each lighting and power circuit for not less than 1/2 hour.
- g. Test shall be conducted per Subsection 100-2.12.

MATERIAL REFERENCES

AC 150/5345-7
AC 150/5345-26

Specification for L-824 Underground Electrical Cable for Airport Lighting Circuit
Specification for L-823 Plug and Receptacle Cable Connectors